

CLAIMS

1. A three-dimensional display method for displaying two-dimensional images, by changing
5 brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, wherein, on a background plane displayed at an arbitrary position in a three-dimensional space,
10 a display object having brightness darker than that of the background plane is displayed, the method comprising:

generating first two-dimensional images that are obtained by projecting the background plane
15 onto the plurality of display planes along a line of sight of the observer, and displaying the first two-dimensional images on the display planes respectively wherein brightness of each of the first two-dimensional images is changed independently for
20 each display plane; and

generating second two-dimensional images that are obtained by projecting the display object onto the plurality of display planes along the line of sight of the observer, and displaying the second
25 two-dimensional images on the display planes respectively in which brightness of each of the two-dimensional images is set to be the same among the display planes.

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2. The three-dimensional display method as claimed in claim 1, wherein the brightness of each
35 of the second two-dimensional images displayed on each display plane is 0.

3. The three-dimensional display method as
5 claimed in claim 1, wherein each of the second two-
dimensional images is a two-dimensional image in
which the displayed brightness is controlled by
pixel values having predetermined levels of gray,
and each pixel value of each of the second two-
10 dimensional images displayed on each display plane
is 0.

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4. A three-dimensional display method for
displaying two-dimensional images, by changing
transparency, on a plurality of display planes
placed at different depth positions as seen from an
20 observer to display a three-dimensional stereoscopic
image, wherein, on a background plane displayed at
an arbitrary position in a three-dimensional space,
a display object having brightness brighter than
that of the background plane is displayed, the
25 method comprising:

generating first two-dimensional images
that are obtained by projecting the background plane
onto the plurality of display planes along a line of
sight of the observer, and displaying the first two-
30 dimensional images on the display planes
respectively wherein transparency of each of the
first two-dimensional images is changed
independently for each display plane; and

generating second two-dimensional images
35 that are obtained by projecting the display object
onto the plurality of display planes along the line
of sight of the observer, and displaying the second

two-dimensional images on the display planes
respectively in which transparency of each of the
two-dimensional images is set to be the same among
the display planes.

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5. The three-dimensional display method as
10 claimed in claim 4, wherein the transparency of each
of the second two-dimensional images displayed on
each display plane is the maximum value.

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6. The three-dimensional display method as
claimed in claim 4, wherein each of the second two-
dimensional images is a two-dimensional image in
20 which the transparency on the display plane is
controlled by pixel values having predetermined
levels of gray, and each pixel value of each of the
second two-dimensional images displayed on each
display plane is a value representing the maximum
25 transparency.

30 7. The three-dimensional display method as
claimed in any one of claims 1-6, wherein,
the display object is character
information;
the background plane is a background of a
35 screen on which the character information is input
or edited; and
a background plane of lines after a line

including a cursor indicating an inputting or editing position of the character information is displayed at a depth position different from a depth position at which a background plane of the line including the cursor and lines before the line including the cursor is displayed.

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8. The three-dimensional display method as claimed in any one of claims 1-6, wherein, the display object is character information;

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the background plane is a background of a screen on which the character information is input or edited; and

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a background plane of a line including a cursor indicating an inputting or editing position of the character information and lines after the line including the cursor is displayed at a depth position different from a depth position at which a background plane of lines before the line including the cursor is displayed.

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9. The three-dimensional display method as claimed in claim 7 or 8, wherein a button or a mark for displaying a menu indicating inputting or editing functions of the character information is displayed on a step part between two background planes displayed at different depth positions.

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10. The three-dimensional display method
as claimed in any one of claims 1-6, wherein,
the display object is character
5 information;
the background plane is a background of a
screen on which the character information is input
or edited; and
a background plane of a selected character
10 information part is displayed at a depth position
different from a depth position at which a
background plane of other character information is
displayed.

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11. The three-dimensional display method
as claimed in any one of claims 1-6, wherein,
20 the display object is character
information;
the background plane is a background of a
screen on which the character information is input
or edited; and
25 a background plane of a character
information part that is searched by a search
function is displayed at a depth position different
from a depth position at which a background plane of
other character information is displayed.

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12. The three-dimensional display method
35 as claimed in any one of claims 1-6, wherein,
the display object is character
information;

the background plane is a background of a table or a menu in which character information are arranged and from which a piece of character information can be selected; and

5 a background plane of a selected character information part is displayed at a depth position different from a depth position at which a background plane of other character information is displayed.

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13. A three-dimensional display apparatus
15 for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, wherein, a display object is an object
20 displayed on a background plane displayed at an arbitrary position in a three-dimensional space, and has brightness darker than that of the background plane, the apparatus comprising:

first means for generating first two-
25 dimensional images that are obtained by projecting the background plane onto the plurality of display planes along a line of sight of the observer;

second means for displaying the first two-
dimensional images generated by the first means on
30 the display planes respectively wherein brightness of each of the first two-dimensional images is changed independently for each display plane so as to display the background plane at an arbitrary position in the three dimensional space;

35 third means for generating second two-dimensional images that are obtained by projecting the display object onto the plurality of display

planes along the line of sight of the observer; and
fourth means for displaying the second
two-dimensional images generated by the third means
on the display planes respectively in which
5 brightness of each of the two-dimensional images is
set to be the same among the display planes.

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14. The three-dimensional display
apparatus as claimed in claim 13, wherein the
brightness of each of the second two-dimensional
images displayed on each display plane is 0.

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15. The three-dimensional display
20 apparatus as claimed in claim 13, wherein each of
the second two-dimensional images is a two-
dimensional image in which the displayed brightness
is controlled by pixel values having predetermined
levels of gray, and each pixel value of each of the
25 second two-dimensional images displayed on each
display plane is 0.

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16. A three-dimensional display apparatus
for displaying two-dimensional images on a plurality
of transmissive display apparatuses placed at
different depth positions as seen from an observer
35 to display a three-dimensional stereoscopic image,
wherein, a display object is an object displayed on
a background plane displayed at an arbitrary

position in a three-dimensional space, and has brightness brighter than that of the background plane, the apparatus comprising:

5 first means for generating first two-dimensional images that are obtained by projecting the background plane onto a plurality of display planes of the transmissive display apparatuses along a line of sight of the observer;

10 second means for displaying the first two-dimensional images on the transmissive display apparatuses respectively wherein transparency of each of the first two-dimensional images is changed independently for each transmissive display apparatus to display the background plane at an
15 arbitrary position in the three-dimensional space; and

third means for generating second two-dimensional images that are obtained by projecting the display object onto the plurality of display
20 planes of transmissive display apparatuses along the line of sight of the observer; and

fourth means for displaying the second two-dimensional images generated by the third means on the transmissive display apparatuses respectively
25 in which transparency of each of the two-dimensional images is set to be the same among the transmissive display apparatuses.

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17. The three-dimensional display apparatus as claimed in claim 16, wherein the transparency of each of the second two-dimensional
35 images displayed on each transmissive display apparatus is the maximum value.

18. The three-dimensional display
5 apparatus as claimed in claim 16, wherein each of
the second two-dimensional images is a two-
dimensional image in which the transparency on the
transmissive display apparatus is controlled by
pixel values having predetermined levels of gray,
10 and each pixel value of each of the second two-
dimensional images displayed on each transmissive
display apparatus is a value representing the
maximum transparency.

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19. The three-dimensional display
apparatus as claimed in any one of claims 13-18,
20 wherein,

the display object is character
information;

the background plane is a background of a
screen on which the character information is input
25 or edited; and

the second means displays a background
plane of lines after a line including a cursor
indicating an inputting or editing position of the
character information at a depth position different
30 from a depth position at which a background plane of
the line including the cursor and lines before the
line including the cursor is displayed.

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20. The three-dimensional display

apparatus as claimed in any one of claims 13-16,
wherein,

the display object is character
information;

5 the background plane is a background of a
screen on which the character information is input
or edited; and

the second means displays a background
plane of a line including a cursor indicating an
10 inputting or editing position of the character
information and lines after the line including the
cursor at a depth position different from a depth
position at which a background plane of lines before
the line including the cursor is displayed.

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21. The three-dimensional display
20 apparatus as claimed in claim 19 or 20, wherein the
second means displays a button or a mark for
displaying a menu indicating inputting or editing
functions of the character information on a step
part between two background planes displayed at
25 different depth positions.

30 22. The three-dimensional display
apparatus as claimed in any one of claims 13-18,
wherein,

the display object is character
information;

35 the background plane is a background of a
screen on which the character information is input
or edited; and

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plane of a selected character information part at a depth position different from a depth position at which a background plane of other character information is displayed.

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25. A program for causing a computer to
10 function as a three-dimensional display apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic
15 image, wherein, a display object is an object displayed on a background plane displayed at an arbitrary position in a three-dimensional space, and has brightness darker than that of the background plane, the program causing the computer to function
20 as:

first means for generating first two-dimensional images that are obtained by projecting the background plane onto the plurality of display planes along a line of sight of the observer;

25 second means for displaying the first two-dimensional images generated by the first means on the display planes respectively wherein brightness of each of the first two-dimensional images is changed independently for each display plane so as
30 to display the background plane at an arbitrary position in the three dimensional space;

third means for generating second two-dimensional images that are obtained by projecting the display object onto the plurality of display
35 planes along the line of sight of the observer; and

fourth means for displaying the second two-dimensional images generated by the third means

on the display planes respectively in which
brightness of each of the two-dimensional images is
set to be the same among the display planes.

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26. The program as claimed in claim 25,
wherein the brightness of each of the second two-
10 dimensional images displayed on each display plane
is 0.

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27. The program as claimed in claim 25,
wherein each of the second two-dimensional images is
a two-dimensional image in which the displayed
brightness is controlled by pixel values having
20 predetermined levels of gray, and each pixel value
of each of the second two-dimensional images
displayed on each display plane is 0.

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28. A program for causing a computer to
function as a three-dimensional display apparatus
for displaying two-dimensional images on a plurality
30 of transmissive display apparatuses placed at
different depth positions as seen from an observer
to display a three-dimensional stereoscopic image,
wherein, a display object is an object displayed on
a background plane displayed at an arbitrary
35 position in a three-dimensional space, and has
brightness brighter than that of the background
plane, the program causing the computer to function

as:

first means for generating first two-dimensional images that are obtained by projecting the background plane onto a plurality of display
5 planes of the transmissive display apparatuses along a line of sight of the observer;

second means for displaying the first two-dimensional images on the transmissive display apparatuses respectively wherein transparency of
10 each of the first two-dimensional images is changed independently for each transmissive display apparatus to display the background plane at an arbitrary position in the three-dimensional space; and

15 third means for generating second two-dimensional images that are obtained by projecting the display object onto the plurality of display planes of transmissive display apparatuses along the line of sight of the observer; and

20 fourth means for displaying the second two-dimensional images generated by the third means on the transmissive display apparatuses respectively in which transparency of each of the two-dimensional images is set to be the same among the transmissive
25 display apparatuses.

30 29. The program as claimed in claim 28, wherein the transparency of each of the second two-dimensional images displayed on each transmissive display apparatus is the maximum value.

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30. The program as claimed in claim 28,
wherein each of the second two-dimensional images is
a two-dimensional image in which the transparency on
the transmissive display apparatus is controlled by
5 pixel values having predetermined levels of gray,
and each pixel value of each of the second two-
dimensional images displayed on each transmissive
display apparatus is a value representing the
maximum transparency.

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31. The program as claimed in any one of
15 claims 25-30, wherein,

the display object is character
information;

the background plane is a background of a
screen on which the character information is input
20 or edited; and

the second means displays a background
plane of lines after a line including a cursor
indicating an inputting or editing position of the
character information at a depth position different
25 from a depth position at which a background plane of
the line including the cursor and lines before the
line including the cursor is displayed.

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32. The program as claimed in any one of
claims 25-30, wherein,

the display object is character
35 information;

the background plane is a background of a
screen on which the character information is input

or edited; and

the second means displays a background plane of a line including a cursor indicating an inputting or editing position of the character information and lines after the line including the cursor at a depth position different from a depth position at which a background plane of lines before the line including the cursor is displayed.

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33. The program as claimed in claim 31 or 32, wherein the second means displays a button or a mark for displaying a menu indicating inputting or editing functions of the character information on a step part between two background planes displayed at different depth positions.

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34. The program as claimed in any one of claims 25-30, wherein,

the display object is character information;

the background plane is a background of a screen on which the character information is input or edited; and

the second means displays a background plane of a selected character information part at a depth position different from a depth position at which a background plane of other character information is displayed.

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35. The program as claimed in any one of
claims 25-30, wherein,

the display object is character
5 information;

the background plane is a background of a
screen on which the character information is input
or edited; and

the second means displays a background
10 plane of a character information part that is
searched by a search function at a depth position
different from a depth position at which a
background plane of other character information is
displayed.

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36. The program as claimed in any one of
20 claims 25-30, wherein,

the display object is character
information;

the background plane is a background of a
table or a menu in which character information are
25 arranged and from which a piece of character
information can be selected; and

the second means displays a background
plane of a selected character information part at a
depth position different from a depth position at
30 which a background plane of other character
information is displayed.

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37. A two-dimensional image generation
method executed by a two-dimensional image output

apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, comprising:

5 a two-dimensional image calculation step of calculating two-dimensional images, each corresponding to a display plane, of a display object and a background from image information of the display object and the background;

10 a brightness value determination step of determining whether a brightness value of the display object is equal to or less than a predetermined threshold and the brightness value of the display object is less than a brightness value of the background; and

15 a brightness value calculation step of, when it is determined that the brightness value of the display object is equal to or less than the predetermined threshold and the brightness value of the display object is less than the brightness value of the background, calculating the brightness value of each two-dimensional image of the background according to depth information of the display object and setting brightness values of the two-dimensional images of the display object to be the same.

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38. A two-dimensional image generation method executed by a two-dimensional image output apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, comprising:

a two-dimensional image calculation step
of calculating two-dimensional images, each
corresponding to a display plane, of a display
object and a background from image information of
5 the display object and the background;

a brightness value determination step of
determining whether a brightness value of the
display object is equal to or less than a
predetermined threshold; and

10 a brightness value calculation step of,
when the brightness value of the display object is
equal to or less than the predetermined threshold,
changing the brightness value of the background to a
value greater than the brightness value of the
15 display object, and calculating the brightness value
of each two-dimensional image of the background
based on the changed brightness value according to
depth information of the display object and setting
brightness values of the two-dimensional images of
20 the display object to be the same.

25 39. A two-dimensional image generation
method executed by a two-dimensional image output
apparatus for displaying two-dimensional images, by
changing transparency, on a plurality of display
planes placed at different depth positions as seen
30 from an observer to display a three-dimensional
stereoscopic image, comprising:

a two-dimensional image calculation step
of calculating two-dimensional images, each
corresponding a display plane, of a display object
35 and a background from image information of the
display object and the background;

a brightness value determination step of

determining whether a brightness value of the display object is equal to or greater than a predetermined threshold and the brightness value of the display object is greater than a brightness value of the background; and

5 a transparency value calculation step of, when it is determined that the brightness value of the display object is equal to or greater than the predetermined threshold and the brightness value of the display object is greater than the brightness value of the background, calculating a transparency value of each two-dimensional image of the background according to depth information of the display object and setting transparency values of the two-dimensional images of the display object to be the same.

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40. A two-dimensional image generation method executed by a two-dimensional image output apparatus for displaying two-dimensional images, by changing transparency, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, comprising:

25 a two-dimensional image calculation step of calculating two-dimensional images, each corresponding a display plane, of a display object and a background from image information of the display object and the background;

30 a brightness value determination step of determining whether a brightness value of the display object is equal to or greater than a predetermined threshold; and

35 a transparency value calculation step of,

when the brightness value of the display object is equal to or greater than the predetermined threshold, changing the brightness value of the background to a value less than the brightness value of the display object, and calculating the transparency value of each two-dimensional image of the background based on the changed brightness value according to depth information of the display object and setting transparency values of the two-dimensional images of the display object to be the same.

41. A two-dimensional image output apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, comprising:

two-dimensional image calculation means for calculating two-dimensional images, each corresponding to a display plane, of a display object and a background from image information of the display object and the background;

brightness value determination means for comparing a brightness value of the display object with another brightness value; and

brightness value calculation means for calculating a brightness value of each two-dimensional image of the display object and the background based on the two-dimensional images calculated by the two-dimensional image calculation means and depth information of the display object and the background;

wherein, when it is determined that the brightness value of the display object is equal to

or less than the predetermined threshold and the
brightness value of the display object is less than
the brightness value of the background by the
brightness determination means, the brightness value
5 calculation means calculates the brightness value of
each two-dimensional image of the background
according to depth information of the display object
and sets brightness values of the two-dimensional
images of the display object to be the same.

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42. A two-dimensional image output
15 apparatus for displaying two-dimensional images, by
changing brightness, on a plurality of display
planes placed at different depth positions as seen
from an observer to display a three-dimensional
stereoscopic image, comprising:

20 two-dimensional image calculation means
for calculating two-dimensional images, each
corresponding to a display plane, of a display
object and a background from image information of
the display object and the background;

25 brightness value determination means for
comparing a brightness value of the display object
with another brightness value; and

brightness value calculation means for
calculating a brightness value of each
30 two-dimensional image of the display object and the
background based on the two-dimensional images
calculated by the two-dimensional image calculation
means and depth information of the display object
and the background;

35 wherein, when it is determined that the
brightness value of the display object is equal to
or less than the predetermined threshold by the

brightness determination means, the brightness value calculation means changes the brightness value of the background to a value greater than the brightness value of the display object, and
5 calculates the brightness value of each two-dimensional image of the background based on the changed brightness value according to depth information of the display object and sets
10 brightness values of the two-dimensional images of the display object to be the same.

15 43. A two-dimensional image output apparatus for displaying two-dimensional images, by changing transparency, on a plurality of transmissive display apparatuses placed at different depth positions as seen from an observer to display
20 a three-dimensional stereoscopic image, comprising:
two-dimensional image calculation means for calculating two-dimensional images, each corresponding to a transmissive display apparatus, of a display object and a background from image
25 information of the display object and the background;

brightness value determination means for comparing a brightness value of the display object with another brightness value; and

30 transparency value calculation means for calculating a brightness value of each two-dimensional image of the display object and the background based on the two-dimensional images calculated by the two-dimensional image calculation means and depth information of the display object
35 and the background;

wherein, when it is determined that the

brightness value of the display object is equal to
or greater than the predetermined threshold and the
brightness value of the display object is greater
than the brightness value of the background by the
5 brightness determination means, the transparency
value calculation means calculates a transparency
value of each two-dimensional image of the
background according to depth information of the
display object and sets transparency values of the
10 two-dimensional images of the display object to be
the same.

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44. A two-dimensional image output
apparatus for displaying two-dimensional images, by
changing transparency, on a plurality of
transmissive display apparatuses placed at different
20 depth positions as seen from an observer to display
a three-dimensional stereoscopic image, comprising:
two-dimensional image calculation means
for calculating two-dimensional images, each
corresponding to a transmissive display apparatus,
25 of a display object and a background from image
information of the display object and the
background;

brightness value determination means for
comparing a brightness value of the display object
30 with another brightness value; and

transparency value calculation means for
calculating a brightness value of each
two-dimensional image of the display object and the
background based on the two-dimensional images
35 calculated by the two-dimensional image calculation
means and depth information of the display object
and the background;

wherein, when it is determined that the brightness value of the display object is equal to or greater than the predetermined threshold by the brightness determination means, the transparency value calculation means changes the brightness value of the background to a value less than the brightness value of the display object, and calculates the transparency value of each two-dimensional image of the background based on the changed brightness value according to depth information of the display object and sets transparency values of the two-dimensional images of the display object to be the same.

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45. A program for causing a computer to function as a two-dimensional image output apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic image, the program causing the computer to function as:

two-dimensional image calculation means for calculating two-dimensional images, each corresponding to a display plane, of a display object and a background from image information of the display object and the background;

brightness value determination means for comparing a brightness value of the display object with another brightness value; and

brightness value calculation means for calculating a brightness value of each two-dimensional image of the display object and the background based on the two-dimensional images

calculated by the two-dimensional image calculation means and depth information of the display object and the background;

5 wherein, when it is determined that the brightness value of the display object is equal to or less than the predetermined threshold and the brightness value of the display object is less than the brightness value of the background by the brightness determination means, the brightness value
10 calculation means calculates the brightness value of each two-dimensional image of the background according to depth information of the display object and sets brightness values of the two-dimensional images of the display object to be the same.

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46. A program for causing a computer to
20 function as a two-dimensional image output apparatus for displaying two-dimensional images, by changing brightness, on a plurality of display planes placed at different depth positions as seen from an observer to display a three-dimensional stereoscopic
25 image, the program causing the computer to function as:

two-dimensional image calculation means for calculating two-dimensional images, each corresponding to a display plane, of a display
30 object and a background from image information of the display object and the background;

brightness value determination means for comparing a brightness value of the display object with another brightness value; and

35 brightness value calculation means for calculating a brightness value of each two-dimensional image of the display object and the

background based on the two-dimensional images
calculated by the two-dimensional image calculation
means and depth information of the display object
and the background;

5 wherein, when it is determined that the
brightness value of the display object is equal to
or less than the predetermined threshold by the
brightness determination means, the brightness value
calculation means changes the brightness value of
10 the background to a value greater than the
brightness value of the display object, and
calculates the brightness value of each two-
dimensional image of the background based on the
changed brightness value according to depth
15 information of the display object and sets
brightness values of the two-dimensional images of
the display object to be the same.

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47. A program for causing a computer to
function as a two-dimensional image output apparatus
for displaying two-dimensional images, by changing
25 transparency, on a plurality of transmissive display
apparatuses placed at different depth positions as
seen from an observer to display a three-dimensional
stereoscopic image, the program causing the computer
to function as:

30 two-dimensional image calculation means
for calculating two-dimensional images, each
corresponding to a transmissive display apparatus,
of a display object and a background from image
information of the display object and the
35 background;

 brightness value determination means for
comparing a brightness value of the display object

with another brightens value; and

transparency value calculation means for
calculating a brightness value of each
two0dimensional image of the display object and the
5 background based on the two-dimensional images
calculated by the two-dimensional image calculation
means and depth information of the display object
and the background;

wherein, when it is determined that the
10 brightness value of the display object is equal to
or greater than the predetermined threshold and the
brightness value of the display object is greater
than the brightness value of the background by the
brightness determination means, the transparency
15 value calculation means calculates a transparency
value of each two-dimensional image of the
background according to depth information of the
display object and sets transparency values of the
two-dimensional images of the display object to be
20 the same.

25 48. A program for causing a computer to
function as a two-dimensional image output apparatus
for displaying two-dimensional images, by changing
transparency, on a plurality of transmissive display
apparatuses placed at different depth positions as
30 seen from an observer to display a three-dimensional
stereoscopic image, the program causing the computer
to function as:

two-dimensional image calculation means
for calculating two-dimensional images, each
35 corresponding to a transmissive display apparatus,
of a display object and a background from image
information of the display object and the

background;

brightness value determination means for comparing a brightness value of the display object with another brightness value; and

5 transparency value calculation means for calculating a brightness value of each two-dimensional image of the display object and the background based on the two-dimensional images calculated by the two-dimensional image calculation means and depth information of the display object
10 and the background;

wherein, when it is determined that the brightness value of the display object is equal to or greater than the predetermined threshold by the
15 brightness determination means, the transparency value calculation means changes the brightness value of the background to a value less than the brightness value of the display object, and calculates the transparency value of each two-dimensional image of the background based on the
20 changed brightness value according to depth information of the display object and sets transparency values of the two-dimensional images of the display object to be the same.

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